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# Exponential Growth Bias Matters: Evidence and Implications for Financial Decision Making of College Students in the U.S.A.

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*Abstract:* This paper tests the exponential growth bias of undergraduate students at a top-level university in the United States and explores the potential drivers of this bias. We find that bias matters, even for college students, in making savings and debt decisions. In this sample, we observe that the individuals who have already taken on debt are more biased, while those who have experience with savings products are less biased. Moreover, those classified as possessing an awareness of compound growth as well as an ability to consistently calculate the compound savings equation are significantly less biased in different savings treatments than those who are unable to make the calculation, further demonstrating that learning the formula may also aid in making better intuitive estimates. Interestingly, we detect no significant differences of university learning in the results between freshmen and upperclassmen, with the exceptions that significantly more upperclassmen claim to have previously learned about compounding interest and are more aware of compound growth. We believe that these findings entail some strong policy implications and we urge policy makers to consider both a more extensive compound savings formula training curriculum to the current Common Core State Standards Initiative and a more experientially-based learning curriculum with a focus on bias “awareness” for these important savings and debt decisions.

*Keywords:* Exponential Growth Bias, Amortization Bias, Household Finance

*JEL Classification:* A2, C91, D14

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## 1. Introduction

*“Compound interest is the eighth wonder of the world. He who understands it, earns it...he who doesn't...pays it.”* - Albert Einstein

Exponential growth bias, defined as a tendency to linearize exponential functions, has been shown to be prevalent in different domains (Wagenaar and Sagaria, 1975; Wagenaar and Timmers, 1979; Keren, 1983), including various household finance decisions (Eisenstein and Hoch, 2007; Stango and Zinman, 2009; Almenberg and Gerdes, 2011; McKenzie and Liersch, 2011; Soll, Keeney, and Larrick, 2013; Goda, Manchester, and Sojourner, 2014; Foltice and Langer, 2015; Levy and Tasoff, 2015). The implications of the exponential growth bias (EGB) for individuals making these savings and debt decisions are immense. For example, Stango and Zinman (2009) have found that those with higher EGB “borrow more and save less” than less biased households. Additionally, Song (2012) finds in a Chinese field study that learning about compound interest can increase pension contributions by about 40%. Moreover, Levy and Tasoff (2015) find that eliminating EGB down from fully biased (i.e. a linear compound estimation) is associated with an increase of up to 90% in accumulated assets.

Acknowledging the importance of such decisions, Foltice and Langer (2015) recently initiated a discussion seeking to identify appropriate ways to reduce or eliminate EGB in various household savings and debt decisions. They tested undergraduate students at a top German university and found evidence in the simple compound savings question that formal formula learning provides not only an effective de-biasing of EGB in the savings questions with an available calculator, it also reduces EGB in these simple savings scenarios as well as in a more complicated debt scenario, when calculators are prohibited. Based on these findings, Foltice and Langer (2015) concluded by urging policy makers to consider adopting a more formal curriculum for learning the simple savings compound formula, that could conceivably fit in the current Common Core State Standards Initiative curriculum in the United States. However,

these findings are in contrast to McKenzie and Liersch (2011), who find no significant difference in bias between the two calculator and non-calculator treatments in a similar study of U.S. undergraduate students. We believe that testing a comparable sample of U.S. students and confirming the results of the German sample in Foltice and Langer (2015) can assist in drawing stronger conclusions and policy recommendations, particularly as the implications of these recommendations would mainly affect U.S. students. Comparing these two samples of U.S. and German students is interesting for three additional reasons. First, previous studies have shown that the general learning style for American educational curriculum is more informal (Hall, 1973) than the German system and teaches students to “get the hang of it” (Friday, 1989) or use a more “best practice” approach to learning (Biggs, 1994). Therefore, we would find it reasonable that the American students will provide better intuitive estimates in the prohibited calculator treatment than the German students, who generally learn through formal learning (Hall, 1973; Friday, 1989; Hall and Hall, 1990; Barmeyer, 2004). Secondly, we will examine if alternative “rules-of-thumb” were used by the U.S. students, such as the Rule of 72<sup>3</sup>, to derive savings estimates in the absence and presence of a calculator. As the Rule of 72 is unknown to most German students, Foltice and Langer (2015) were unable to determine the effectiveness of learning this alternative heuristic.. Finally, in addition to testing the exponential growth bias in the savings domain with and without a calculator, we are interested in asking this sample of U.S. students to estimate exponentially-based debt questions on the remaining balance of a loan with an available calculator. Considerably more college students in the U.S. are placed in a position early in life to make debt decisions than a typical German student. In 2013, over 70% of all graduates from a four-year college in the U.S. have taken on loans (The Institute for College Access & Success, 2014), compared to the 6% student population of Germans who have reportedly taken out a private student loan, according to Middendorff et al. (2013). Foltice

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<sup>3</sup> The Rule of 72 provides estimates on how many times an initial amount will double over time.

and Langer (2015) tested German students in this domain and found strong evidence of the “amortization bias”, which is the tendency to linearly estimate the remaining balance on loan at various points of paying off a debt. In this study, we are not only interested in observing any differences in bias size in these debt questions compared to Foltice and Langer (2015), we would also like to evaluate the bias strength of the students who already have experience in debt within both the savings and debt domains.

The second part of this paper examines the possible learning effects of university level education as it pertains to the exponential growth bias. Foltice and Langer (2015) found that the extensive learning of the compound growth formula can be retained over time, as 95% of the upperclassmen business majors, could correctly answer this question with a calculator approximately 18-20 months after their initial learning. These findings are also in conflict with most literature on financial education, which predominantly finds that even extensive and time-consuming interventions have negligible benefits “20 months or more” from the time of learning (Fernandes, Lynch, and Netemeyer, 2014). In order to examine the university learning effects in this paper, we test two sub-groups of undergraduate students. The first group includes incoming freshmen, who were tested in their first few weeks on campus. The second group comprises juniors and seniors, whom we refer to as “upperclassmen” in our analysis.<sup>4</sup> If we can detect bias improvement in the university learning in this U.S. sample, we can explore more deeply ways to refine the methods of learning that maximize long-term learning effects. If no improvements are found, we should reexamine the current program of learning and suggest pursuing alternative methods of learning for university students.

Finally, this paper explores the drivers of the exponential growth bias. Gaining a clearer understanding of these will not only allow us to better address the more appropriate approach to reducing EGB, it will also provide a first look at how this bias plays a role in savings and

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<sup>4</sup> Sophomores were prohibited from participating in this experiment.

debt decisions for college students. More precisely, we would like to analyze if EGB is driven by experiences, and if it can be predicted by formalized tests, such as financial literacy (van Rooj, Lusardi, and Alessie, 2011) or numeric proficiency (Lipkus, Samsa, and Rimer, 2001).

This paper provides a number of interesting findings and new insights into understanding EGB which can be utilized to address ways of reducing bias for these important financial decisions. First, we show consistent EGB results with the freshmen sample of German students in Foltice and Langer (2015) in both the savings domain, with and without a calculator, and in the debt domain. However, in our U.S. sample, we find no significant differences in bias, financial literacy or numeric proficiency between the freshmen and upperclassmen, despite the exceptions that significantly more upperclassmen claimed to have previously learned about compounding interest and are more aware of compound growth effects. In the final section, we find strong evidence that experience matters, even for college students, in determining the size of EGB, though the best method of predicting and driving bias in each domain is not always the same. In the savings domain, we find clear evidence of reduced bias in both treatments from those who could correctly calculate the exponential formula with a calculator, demonstrate an awareness of the effects of compound growth, and possess experience in savings products. In the savings treatment without an available calculator, we detect a significantly larger exponential growth bias size from those individuals with already have experience with debt products. Finally, in the more complicated debt scenario, previous experience in savings and debt products best predicts bias size. The policy implications and potential opportunities for future research are presented in the conclusion and discussion section.

## **2. Experimental Setup**

This experiment analyzes undergraduate students at a top U.S. University in a computer-based experiment that was conducted in a controlled lab. As previously mentioned, we want to initially compare the results and university learning effects with the German sample in Foltice and

Langer (2015) who exclusively evaluate freshmen and upperclassmen near the end of their Bachelors program. Thus, we only permitted freshmen, juniors and seniors to participate in the experiment.

### ***Incentives***

Each student received a flat payment of \$10 and an additional variable payment for participating in the experiment. The variable payout ranged from \$1-\$10, which was determined by the accuracy of one randomly chosen question out of the 24 overall savings and debt questions, providing a total possible payout of \$11 to \$20 for participating in the experiment. The experiment was designed to take approximately 60 minutes to complete, though we did not place any explicit time restrictions on completion times.

### ***Experimental Design***

Each participant answered a total of 24 questions, 16 savings and 8 debt. In this experiment, the first eight savings questions were answered without an available calculator. In this round (1), individuals were permitted to use a pen and paper provided by the experimenter in the computer lab, but were prohibited to use calculators or electronic devices, including the Internet on their computer. Upon completion of round 1, a calculator was provided by the experimenter and the participant was asked to complete the remaining 16 (eight savings and eight debt) questions in round 2. We follow the same savings question structure as Eisenstein and Hoch (2007) and Foltice and Langer (2015), where two types of question frames are presented: prospective and retrospective. The prospective and retrospective savings questions ask the following:

#### ***Prospective Savings Question***

*You currently have a balance of \$10,000 in your account. You leave this money in your savings account for \_\_\_ years at a constant annual interest rate of \_%.*

*Assume no additional deposits or withdrawals. Interest is compounded annually and reinvested into the account.*

*Based on the above information, estimate your total account balance after \_\_\_ years. Please provide your best estimate.*

### ***Retrospective Savings Question***

*Your goal is to have \$100,000 in your savings account \_\_\_ years from today. Today, you will invest an initial amount of money in your savings account for \_\_\_ years at a constant interest rate of \_\_\_% per year.*

*Assume no additional deposits or withdrawals. Interest is compounded annually and reinvested into the account.*

*How much do you need to invest today in order to reach your savings goal in \_\_\_ years? Please provide your best estimate.*

We follow a two-by-two question vector for the four prospective and retrospective savings questions, time in years and annual interest, which is consistent with experiment 2 in Foltice and Langer (2015).<sup>5</sup> We add an additional eight debt questions to the experimental design in round 2. The format for the eight debt questions is shown below:

### ***Debt Question***

*Today, you borrow \$\_\_\_\_\_ for \_\_\_\_\_ years, paying a yearly fixed interest rate of \_\_\_\_\_%, agreeing to pay off the entire loan plus interest by making \_\_\_\_\_ equal monthly payments.*

*Assume all payments have been made on time and no additional payments have been made.*

*After making payments on this loan for \_\_\_\_\_ years (\_\_\_ payments), what is the remaining balance of the initial loan? Please provide your best estimate.*

These eight debt questions comprised four mid-term 10-year loans with an initial balance of \$20,000, and four long-term 30-year loans with an initial balance of \$200,000. A two-by-two matrix, posted in Appendix 1, was designed for both the mid-term and long-term loans (6% and 10% yearly interest rate with 50% and 75% time remaining on the loan) to also mirror the questions in experiment 2 of Foltice and Langer (2015). The experiment overview is outlined in Table 1.

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<sup>5</sup> Time in years - 12 and 36; Annual interest rate – 7% and 12%. A full overview is shown in Appendix 1.



**Table 1. Experiment overview** - This figure outlines the experiment activity by round and question domain. Experiment screenshots can be found in Supplement A.

<b>Round 1 (without calculator)</b>	
4 Savings Questions (Prospective) 4 Savings Questions (Retrospective)	Random Order*
<b>Round 2 (with calculator)</b>	
8 Savings Questions (4 Prospective/4 Retrospective)	Random Order*
8 Debt Questions (4 Mid Term/4 Long Term)	Random Order**
<b>Round 3 (with calculator)</b>	
5 Financial Literacy Questions 10 Question Numeracy Quiz Personal Information/Experiment Feedback	

\* In each savings round, all prospective and retrospective questions were taken together.

\*\* The order of question and question type were both randomized.

### ***Methodology and Analysis Set Up***

In this sample, a total of 207 participants completed the experiment and comprised 104 freshmen and 103 “upperclassmen”, who are juniors and seniors. For the savings analysis, we eliminate participants with more than three insensible answers in savings rounds 1 or 2. In the debt domain, we relax the restrictions slightly and eliminate participants with more than five insensible answers.<sup>6</sup> Answers are deemed “insensible” if less (greater) than the initial amount in the prospective (retrospective) frame in the savings domain and greater than the initial loan amount in the debt domain. All answers less than \$0 would also be considered insensible in each of these sections. After this filter is applied, 17 (61) participants are eliminated in the savings (debt) domain, leaving 190 (146) participants in the analysis for each domain.

### ***Bias Measurement***

In order to capture bias in different domains and for different parameters, we use the  $\theta$  measure introduced in Foltice and Langer (2015). It is based on an accumulation function:

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<sup>6</sup> This is consistent with the methodology of Foltice and Langer (2015) in both domains.

$$f_{i,t}(\theta) = (t \cdot i)^{(\theta)} \cdot ((1 + i)^t - 1)^{(1-\theta)} + 1 \quad (1)$$

where  $i$  is the annual interest rate and  $t$  the time horizon in years. This accumulation function reduces to an exponential accumulation  $f_{i,t}(\theta) = (1 + i)^t$  for  $\theta=0$  and to a linear accumulation  $f_{i,t}(\theta) = 1 + (t \cdot i)$  for  $\theta=1$ . The function is strictly monotonic and continuous and can be used to back out an underlying  $\theta$  for any sensible answer in the savings as well as in the debt domain.

In the savings domain the relation between the present value (PV), the future value (FV), and the accumulation factor is simple. It holds:

$$FV = PV \cdot f_{i,t}(\theta), \quad (2)$$

where in the prospective (retrospective) scenario PV (FV) is given and FV (PV) elicited. In both cases  $\theta$  is determined to satisfy equation (2), i.e.  $\theta = f_{i,t}^{-1}(\frac{FV}{PV})$ .

This procedure is able to assign a  $\theta$  to any sensible answer and is calibrated in so far as it yields a bias of  $\theta = 0$  for a perfectly exponential and  $\theta = 1$  for a linear answer.<sup>7</sup>

In the debt domain the situation is a little less obvious but it can be shown that the  $\theta$  measure nicely extends to an amortization scenario where  $B$  is the remaining balance after  $n$  payments on a loan with an initial amount  $A$  that is to be paid back with  $N$  equal installments.<sup>8</sup> The general equation:

$$B = A \cdot \left[ 1 - \frac{f_{i,n}(\theta) - 1}{f_{i,N}(\theta) - 1} \right] \quad (3)$$

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<sup>7</sup> To be sensible any estimate of FV (or PV) should be positive and it should hold:  $FV > PV$ .

<sup>8</sup> For details see Foltice and Langer (2015).

reduces to the correct formula  $B = A \cdot \left[1 - \frac{(1+i)^n - 1}{(1+i)^N - 1}\right]$  for  $\theta = 0$  and describes linear depreciation  $B = A \cdot \left[1 - \frac{n}{N}\right]$  for  $\theta = 1$ . The depreciation term is strictly monotonic in  $\theta$  on the relevant range and can be used to assign a bias size  $\theta$  to any sensible answer.<sup>9</sup>

### 3. Savings and Debt Results

This section reports the strength of biases across domains and treatments, with and without calculators. In Table 2, we can identify a statistically significant bias (overall median  $\theta$  of 0.58) in round 1 (without a calculator), with 69.6% of all answers underestimating (or overestimating) the actual answer in the prospective (retrospective) frame. Similar to Foltice and Langer (2015), medians are analyzed in this paper, as the results are not normally distributed, based on the Shapiro-Wilk and Shapiro-Francia tests. As depicted in Figure 1, the hollow data points (triangles and squares) show that the median estimates in round 1 for the long-term prospective questions struggle to adjust upward from the linear estimate. These results are consistent with Foltice and Langer (2015), who find median estimates roughly 10% over each linear estimate in the prohibited calculator treatment.

We also see in Table 2 that when calculators are allowed in round 2, only 30.5% of the savings questions are answered correctly, +/- \$1 of the actual answer. This is 11.3% less than the freshmen German sample in experiment 1 of Foltice and Langer (2015), and is considerably less than their German upperclassmen sample in experiment 2, who post the correct answer for nearly 90% of all savings questions.

In order to determine if an alternative heuristic was used in the place of the actual formula, we asked each participant to explain how they “attempted to answer each question” after answering the four prospective and four retrospective questions in round 1. In the analyzed sample, only

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<sup>9</sup> In the amortization scenario a sensible estimate for the remaining balance  $B$  should be between 0 and the initial loan amount  $A$ .

two participants claim to have used the Rule of 72 to estimate these questions without a calculator. In fact, the experiment is designed in a way that four out of the eight savings questions fit the Rule of 72 perfectly.<sup>10</sup> Unfortunately, only three answers (out of the possible eight) from these two participants are calculated correctly, based on these rules of thumb. When we examine the data set in round 1 more closely, we detect three additional participants with more than one correct estimate in accordance with the Rule of 72, although they didn't explicitly state that they used this heuristic.

**Table 2. Overall group level descriptive statistics for savings questions, sorted by question and round.** Note: the prospective question starts with an initial amount of \$10,000 and the retrospective question asks how much money one needs today in order to achieve the savings goal of \$100,000 in  $x$  years. Interest rate and years are listed below, respectively. Calculators were prohibited (allowed) in round 1 (2).

	<b>Rd. 1 (without calculator)</b>			<b>Rd. 2 (with calculator)</b>		
<b>Question</b>	<b>N</b>	<b>Median <math>\theta</math></b>	<b>Biased<sup>†</sup></b>	<b>N</b>	<b>Median <math>\theta</math></b>	<b>Correct<sup>°</sup></b>
Prospective; 0.07; 12	185	0.56***	63.2%	185	0.00	33.2%
Prospective; 0.12; 12	189	0.53***	68.3%	188	0.00***	37.4%
Prospective; 0.07; 36	189	0.77***	81.0%	188	0.00***	34.7%
Prospective; 0.12; 36	188	0.94***	88.3%	186	0.02	34.2%
<b>All Prospective</b>	<b>751</b>	<b>0.78***</b>	<b>75.2%</b>	<b>747</b>	<b>0.00***</b>	<b>34.9%</b>
Retrospective; 0.07; 12	187	0.06**	51.3%	186	0.00	23.2%
Retrospective; 0.12; 12	189	0.27	54.5%	186	0.00	27.4%
Retrospective; 0.07; 36	188	0.43***	64.4%	188	0.00***	26.8%
Retrospective; 0.12; 36	187	0.72***	86.1%	188	0.14***	26.8%
<b>All Retrospective</b>	<b>751</b>	<b>0.43***</b>	<b>64.0%</b>	<b>748</b>	<b>0.00***</b>	<b>26.1%</b>
<b>All Medium-Term</b>	<b>750</b>	<b>0.41*</b>	<b>59.3%</b>	<b>745</b>	<b>0.00**</b>	<b>30.2%</b>
<b>All Long-Term</b>	<b>752</b>	<b>0.77***</b>	<b>79.9%</b>	<b>750</b>	<b>0.00***</b>	<b>30.7%</b>
<b>All Savings</b>	<b>1502</b>	<b>0.58***</b>	<b>69.6%</b>	<b>1495</b>	<b>0.00***</b>	<b>30.5%</b>

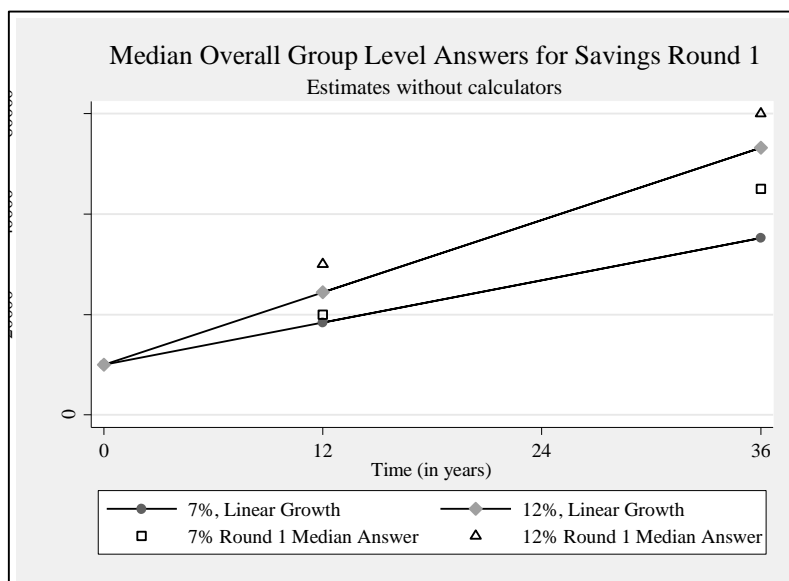
<sup>†</sup> Answers less (greater) than actual answer in the prospective (retrospective) frame. An answer would need to be more than \$1 less (greater) than the actual answer to be placed in this category.

<sup>°</sup> Answers within \$1 +/- of the answer using the compound interest formula

\* 90% - \*\* 95% - \*\*\* 99% Statistical Significance (Wilcoxon signed rank test)

<sup>10</sup> The prospective and retrospective questions with 12% annual interest and times of 12 and 36 years fit the Rule of 72 perfectly. Based on this rule of thumb, the 12%/12 year question would double (halve) two times, while the 12%/36 year question would double (halve) six times. None of the participants claimed to use the similar Rule of 70 in this experiment.

**Figure 1. Median overall group level answers for the prospectively framed savings questions in round 1 (estimates given without an available calculator).** The connected line signifies the linear answer for each question and the hollow shapes denote the median answer.



In the debt domain, we find results in Table 3 similar to the German undergraduate students who completed the same set of questions in Foltice and Langer (2015), whereby five of the eight debt questions post the exact same median  $\theta$ . Again, the median  $\theta$  at the overall level is the linear estimate of 1.00. In this domain, 77.0% of the answers underestimate the remaining balance on a loan.<sup>11</sup> In the four long-term questions, which were designed to appear similar to a traditional 30-year mortgage on an average sized house in the U.S., we find that 89.1% of all answers underestimated the amount remaining on a loan, with a median  $\theta$  of 1.00. Based on the reduced number of overall observations (936) in the debt domain compared to the 1502 savings observations, we note that many answers were given outside of the “sensible” \$0-\$20,000 and \$0-\$200,000 ranges. This is due to the fact that, similar to Foltice and Langer (2015), many of these answers use a variation of the compound savings formula and apply the parameters of the debt question to derive an answer well over the \$20,000/\$200,000 initial balance of the loan.

<sup>11</sup> 77.2% of the overall estimates in the German sample (Foltice and Langer, 2015) underestimated.

**Table 3. Overall debt results summary, sorted by question and sample.** MT = mid-term, original loan amount of \$20,000; LT = long-term, original loan amount of \$200,000. 0.06 and 0.10 indicate the annual interest rate on the loan. ,5 and ,75 indicate the remaining time on the loan (as a percentage). The German results are from Foltice and Langer (2015), who initially test fourth semester undergraduate students in Germany, who are majoring in Business.

American Sample						German Sample		
Question	N	Median $\theta$	Median	Correct	Biased†	N	Median $\theta$	Biased†
MT; 0.06; 0,5	134	0.45	\$10,850	\$11,485	51.8%	162	-0.01	49.4%
MT; 0.06; 0,75	110	1.00***	\$15,000	\$16,061	68.4%	157	1.00***	69.4%
MT; 0.10; 0,5	108	0.74***	\$10,700	\$12,439	64.8%	136	1.00***	66.9%
MT; 0.10; 0,75	119	1.00***	\$15,000	\$16,688	79.5%	150	1.00***	72.7%
<b>All Mid-Term</b>	<b>471</b>	<b>0.70***</b>			<b>65.7%</b>	<b>605</b>	<b>1.00***</b>	<b>64.3%</b>
LT; 0.06; 0,5	119	0.89***	\$106,000	\$142,098	77.7%	138	0.89***	85.5%
LT; 0.06; 0,75	122	1.00***	\$150,000	\$177,440	91.1%	145	1.00***	88.3%
LT; 0.10; 0,5	112	0.97***	\$104,750	\$163,329	93.0%	135	0.94***	94.1%
LT; 0.10; 0,75	112	1.00***	\$150,000	\$188,210	94.8%	142	1.00***	97.1%
<b>All Long-Term</b>	<b>465</b>	<b>1.00***</b>			<b>89.1%</b>	<b>560</b>	<b>1.00***</b>	<b>91.3%</b>
<b>All Debt</b>	<b>936</b>	<b>1.00***</b>			<b>77.0%</b>	<b>1165</b>	<b>1.00***</b>	<b>77.2%</b>

\* 90% - \*\* 95% - \*\*\* 99% Statistical Significance (Wilcoxon signed rank test)

† Answers less than actual answer.

#### 4. University Learning Results

Next, in Table 4, we report  $\theta$  at the individual level and divide the overall sample into their respective groups, based on seniority. Also, after completing the savings and debt questions in the experiment, we ask each participant if they had previous experience with:<sup>12</sup>

1. Using savings products, such as savings, brokerage, or investment accounts, etc.
2. Using debt products, such as student/auto loans or mortgages, etc.
3. Learning the compounding interest formula.

We also ask five basic financial literacy questions (van Rooj, Lusardi, and Alessie, 2011). The first two financial literacy questions address whether an individual possesses an awareness of general savings growth and compounding effects. For instance, the two questions regarding

<sup>12</sup> See supplement A for full details of each question.

compounding growth in this financial literacy test ask (correct answer provided below in bold text):

1. *Suppose you had \$100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow? a. **More than \$102** b. Exactly \$102 c. Less than \$102 d. I don't know*
2. *Suppose you had \$100 in a savings account and the interest rate is 20% per year and you never withdraw money or interest payments. After 5 years, how much would you have in this account in total? a. **More than \$200** b. Exactly \$200 c. Less than \$200 d. I don't know*

While question 1 only tests for a very elementary understanding of multi-year interest, answering the more complicated question 2 correctly (a.) would imply a  $\theta$  of less than 1, which is less than being fully (linearly) biased. Although the correct answer doesn't rule out the possibility of strong EGB, it shows that an individual is at least aware of the compounding effects. Therefore, in our analysis, by answering these two questions correctly, we classify a participant as being "aware of compound growth". For the financial literacy results in this analysis, the number of correct answers out of the remaining three financial literacy questions is posted in Table 4.

Additionally, we would like to evaluate if numeric proficiency plays a significant role in driving EGB. Previous studies have shown that more numerically-minded individuals can make better estimates in the debt domain (Peters et al., 2006; Soll, Keeney, and Larrick, 2013). Therefore, we asked each participant to complete a ten-question numeracy quiz, as originally provided by Lipkus, Samsa, and Rimer (2001).

When we compare the differences between the freshmen and upperclassmen in Table 4, we find no significant differences in financial literacy, numeracy, and experience in debt or savings. We

find that 70.7% of the upperclassmen state that they've previously learned about compound interest, which is significantly more than the freshmen sample, where only 48.0% state a previous learning. We also find significantly more upperclassmen posting an awareness of compound growth. However, across each sub-group in each round and domain, this learning does not appear to be making much of an impact as we find no significant differences when comparing biases of the two groups of freshmen and upperclassmen in a Wilcoxon rank-sum test. Despite the significant difference of previous learning experience and awareness during the time spent at the university, only 35.9% of the upperclassmen could consistently generate the correct calculation with a calculator, compared to 32.7% of the freshmen sample.



**Table 4. Individual descriptive statistics and results summary, sorted by seniority and round.** Individual results were recorded as the median  $\theta$  for all relevant answers for each participant. “Comp. Growth Aware” denotes that the first two questions in the financial literacy quiz regarding compound growth were answered correctly, signifying a general awareness of compound growth effects. Results for the remaining three financial literacy and ten numeracy quiz questions are the average correct answers for each group. At the end of the survey, participants stated if they had previous experience with various savings and debt products as well as if they had previously learned compounding interest. Each participant was required to have at least five sensible answers in each of the two savings and at least three sensible answers in the one debt section to be counted in the data set. “Correct Calculation” in round 2 denotes that the individual correctly calculated three or more of the eight savings questions with an available calculator within \$1 of the actual answer.

Group	All	Freshmen	Upperclassmen	Difference	t-score (z-)
N - Participants	190	98	92		
Male	36.3%	37.8%	34.8%	-3.00%	-0.42
Comp. Growth Aware	79.5%	72.4%	87.0%	14.5%***	2.50
Financial Literacy	3.96	3.89	4.04	0.16	1.04
Numeracy Quiz	9.11	9.20	9.01	-0.19	-1.01
Experience in Savings	6.8%	6.1%	7.6%	1.5%	0.40
Experience in Debt	33.2%	33.7%	32.6%	-1.1%	-0.16
Prev. Learned Comp.	58.9%	48.0%	70.7%	22.7%***	3.25
<b>Savings Round 1 (without calculators)</b>					
Median $\theta$	0.60***	0.56***	0.72***	0.16	(1.33)
$\theta > 0.00$	76.3%	73.4%	79.3%	5.90%	0.95
<b>Savings Round 2 (with calculators)</b>					
Median $\theta$	0.00***	0.00***	0.00***	0.00	(0.38)
$\theta > 0.00$	42.1%	42.9%	41.3%	-1.6%	-0.22
Correct Calculation	34.2%	32.7%	35.9%	3.2%	0.46
<b>Debt Questions</b>					
N - Participants	146	69	77		
Median $\theta$	1.00***	0.89***	1.00***	0.11	(0.81)
$\theta > 0.00$	88.4%	85.5%	90.9%	5.4%	1.01

Wilcoxon signed-rank test was used for the median  $\theta$  analysis. Two sample t-tests were used to compare the differences between the freshmen and upperclassmen sub-groups, with the exception of the analysis of median  $\theta$  differences, which used a Wilcoxon rank-sum test. For all tests, \*  $p < .10$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ .

## 5. Analyzing Drivers of EGB

In order to analyze the drivers of the exponential growth bias, we run a series of quantile regressions, as median  $\theta$ 's are not normally distributed in each domain and treatment, per the Wilk-Shapiro and Wilk-Francia tests of normality. In Table 5, regression model (1) analyzes the three aforementioned experience components as it pertains to the overall  $\theta$  output in each

domain and treatment: previous experience learning about compound interest, experience with various debt products/loans, and experience with savings products. In alignment with the findings of Stango and Zinman (2009), we anticipate that those individuals with savings experience will provide less biased estimates in both savings rounds, while those who have experience with debt will possess a larger EGB in both savings rounds, with and without a calculator. We are cautiously hopeful that there will be more accurate estimates and calculations from those who have claimed to have previously learned about compound interest in both savings treatments, but are unsure if the “stickiness” of the learning over time will side with the results of Foltice and Langer (2015) or the aforementioned general findings in financial literacy interventions summarized by Fernandes, Lynch, and Netemeyer (2014). We include the gender and the seniority of each participant as additional variables for each regression in this analysis.

Regression model (2) evaluates the results of the two formalized tests taken at the end of the experiment, which include the results of three out of the five financial literacy questions as well as the ten numeracy quiz questions. The additional compound growth awareness dummy variable is included in this regression, whereby an individual possessing “compound growth awareness” answers the first two questions of the financial literacy test correctly.

Regression model (3) combines the three experiential components of regression model (1) with the three formalized test variables evaluated in regression model (2).

Finally, regression model (4) adds one additional dummy variable to the regression model (3): we classify those who can consistently calculate the correct savings answers with a calculator and place these individuals in the “Correct Calculation” group if they calculate three or more of the eight savings questions in round 2 (with an available calculator) within \$1 of the actual answer. This proxy allows us to better distinguish those individuals who can correctly apply the formula from those who have stated a previous learning of compound interest.

In Table 5, we find that experience matters in determining exponential growth bias. Here, those with experience in debt are significantly more biased in the savings domain round 1, while those who already have experience in savings products are significantly less biased in this treatment without a calculator. Despite a much smaller sample size, these findings coincide with the previous findings of Stango and Zinman (2009). Furthermore, in the debt domain, individuals with savings and debt experience provide significantly less biased estimates in the debt domain. While some would argue that those with experience in debt should be more biased in this domain, these results speak in favor of the potential effectiveness of experiential learning, as these individuals are conceivably more likely to know how a loan amortizes over time based on first-hand experience. It also supports Foltice (2015), who find a greater bias improvement over time in the debt domain in the experiential learning group compared to those who received a formula-based learning.

In regression model (1), previous experience in learning about compound interest appears to significantly reduce EGB in the savings domain with an available calculator. However, when we add the additional formalized testing and “correct calculation” variables to regression models (3) and (4), we find this learning experience no longer plays a significant role in the reduction of EGB. Instead, we observe that EGB is significantly reduced in the savings domain by two main factors: compound growth awareness and the ability to correctly calculate the formula. As shown in regression model (4), these two factors play similarly significant roles in reducing EGB both with and without a calculator. Finally in regression model (4), in the savings round 1 without a calculator, those who have stated a previous learning are significantly more biased. Here, the reduction of EGB is driven by the “compound growth awareness” and “correct calculation” variables.

In regression models (3) and (4), higher numeracy quiz results appear to reduce EGB in the debt domain, which is consistent with the findings of Peters et al. (2006) as well as Soll, Keeney,

and Larrick (2013). However, higher numeracy results significantly increase EGB in the savings domain without a calculator, as shown in regression model (4). Finally, we find no significant influence of financial literacy results on the EGB size in any of the regressions throughout the entire analysis.

**Table 5. Quantile regression results, by round and domain.**

	Round 1 - Savings (w/o calculator)				Round 2 - Savings (w/ calculator)				Round 2 - Debt (w/ calculator)			
<b>Participant Characteristics</b>	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Intercept	0.504*** (0.074)	0.698** (0.276)	0.311 (0.266)	0.237 (0.260)	0.145* (0.058)	0.931*** (0.099)	0.931*** (0.131)	0.925*** (0.268)	1.000*** (0.022)	0.971*** (0.129)	1.102*** (0.094)	1.181*** (0.106)
Male	-0.006 (0.074)	-0.057 (0.077)	-0.005 (0.071)	-0.005 (0.071)	0.000 (0.059)	0.000 (0.028)	0.000 (0.028)	0.000 (0.073)	0.000 (0.021)	0.013 (0.037)	0.017 (0.026)	0.002 (0.030)
Upperclassmen	0.064 (0.073)	0.102 (0.075)	0.144* (0.070)	0.103 (0.069)	0.000 (0.058)	0.000 (0.027)	0.000 (0.027)	0.000 (0.071)	0.000 (0.021)	0.016 (0.047)	0.000 (0.026)	-0.007 (0.030)
<b>Experience</b>												
Learned Compound Interest	0.052 (0.075)		0.111 (0.072)	0.171** (0.071)	-0.145* (0.059)		-0.000 (0.035)	-0.000 (0.073)	0.000 (0.022)		0.051* (0.027)	0.042 (0.031)
Experience with Debt	0.328*** (0.076)		0.210*** (0.074)	0.194*** (0.073)	0.000 (0.060)		0.001 (0.035)	0.000 (0.075)	-0.197*** (0.022)		-0.179*** (0.026)	-0.174*** (0.030)
Experience with Savings	-0.445** (0.076)		-0.410*** (0.133)	-0.261** (0.131)	0.000 (0.058)		-0.001 (0.035)	-0.000 (0.133)	-0.189*** (0.037)		-0.189*** (0.045)	-0.197*** (0.052)
<b>Formalized Testing</b>												
Comp. Growth Aware		-0.465*** (0.101)	-0.370*** (0.092)	-0.325*** (0.090)		-0.930*** (0.036)	-0.926*** (0.045)	-0.562*** (0.092)		0.006 (0.047)	0.000 (0.033)	0.007 (0.037)
Financial Literacy		0.001 (0.046)	0.010 (0.043)	0.008 (0.077)		0.000 (0.017)	0.000 (0.021)	-0.000 (0.043)		0.019 (0.022)	0.000 (0.015)	-0.001 (0.017)
Numeracy Quiz		0.028 (0.030)	0.045 (0.028)	0.054* (0.028)		-0.000 (0.011)	-0.001 (0.014)	-0.000 (0.029)		-0.006 (0.014)	-0.017* (0.010)	-0.025* (0.011)
<b>Consistent Calculation</b>												
Correct Calculation				-0.320*** (0.074)				-0.363*** (0.076)				0.030 (0.033)
N (observations)	1502	1502	1502	1502	1495	1495	1495	1495	936	936	936	936

## 6. Conclusion and Discussion

This paper tests the exponential growth bias (EGB) of undergraduate students at a top level university in the U.S. and explores the potential drivers of the bias. We provide a number of interesting findings and new insights into understanding exponential growth bias. First, we show consistent EGB results in this sample of U.S. undergraduate students as with the German students in Foltice and Langer (2015) in the prohibited calculator savings treatment. However, unlike the German sample of Foltice and Langer (2015), we find no significant differences in any of the results between freshmen and upperclassmen in this sample, with the exception that significantly more upperclassmen claimed to have previously learned about compounding interest and have more awareness of compound growth, even though this is not reflected in their answers. This is an alarming finding, as there is an apparent effort being made to teach university students about compound growth, but is not producing long-lasting improvements in EGB, particularly when it comes to making personal finance decisions.

Furthermore, we find that bias matters, even at an early age, in making savings and debt decisions. Consistent with the findings of Stango and Zinman (2009), we observe that the individuals who have already taken on debt are significantly more biased in the prohibited calculator savings treatment. Meanwhile, the small sample of participants with experience with various savings products is significantly less biased in this same treatment.

In the debt domain, both groups of these experienced individuals are significantly less biased. While these results are in conflict with the intuition that more biased individuals take on more debt, it speaks in favor of the experiential learning likely received by those who have experience with debt.

Furthermore, we find that the best method of predicting bias in each domain is not always the same: in the savings domain, we find clear evidence of reduced bias in both treatments from

those who are aware of the bias and can correctly calculate the exponential formula, while experience in savings and debt products tends to reduce bias in the more complicated debt scenario.

In this sample, previous learning experience of compound interest does not eliminate or significantly reduce bias, which calls to question the learning methods and the effectiveness used in the curriculums; particularly, but not exclusive to, the university level. In our sample, only 34% of undergraduate students at a top university in the U.S. are able to correctly calculate compound interest in the savings domain with an available calculator. We also conducted an unpublished pilot test for this experiment consisting of 42 undergraduate business students at a private university and found only 7% could make this correct calculation in the savings domain. In our sample, only two students out of 190 claimed to use an alternative “rule-of-thumb” heuristic, such as the Rule of 70 or 72, in making estimates in the prohibited calculator treatment, which casts serious doubts about the effectiveness of learning such an alternative heuristic.

We believe that these findings contain some strong policy implications and potential opportunities for learning improvement. First, this paper further supports Foltice and Langer’s (2015) suggestion to implement a policy shift that introduces a more extensive learning of the compound savings formula into the present Common Core State Standards Initiative curriculum, which currently expects all 8<sup>th</sup> grade students to be able to calculate simple exponential growth equations. This suggestion provides a cost effective alternative to the current push for increased general education in personal finance and improved financial literacy (Hilgert, Hogarth, and Beverly, 2003; Greenspan, 2005; Morton, 2005; Lusardi and Mitchell, 2007; Mishkin, 2008; U.S. Congress, 2010; Cordray, 2013), which is costing billions of dollars annually, but only explains 0.1% of the variance of the analyzed financial behaviors (Fernandes, Lynch, and Netemeyer, 2014). Our suggestion also tackles the major “training the trainers”

issues described by Way and Holden (2009), which hampers the effective implementation of the learning curriculum on a large scale.<sup>13</sup>

There is also a potential learning opportunity for improvement in bias at the university level. Based on our results, some efforts are being made to offer learning opportunities to university students about compound growth. We propose that school administrators, faculty, researchers, and policy makers should contemplate introducing an introductory course for all incoming freshmen that provides a formal compound savings formula learning/review coupled with a more experientially-based learning curriculum with a focus on increasing bias “awareness” for the applicable savings and debt decisions.

We realize these are only two broad suggestions that aim to improve household financial decision making and we hope it motivates future research. We are keenly aware that formal formula learning is not for everyone, nor is it the optimal learning method for each household savings and debt decision. In the more complicated debt domain, we find evidence in this paper and in Foltice (2015) that experiential learning could provide more effective and long-lasting retention of reducing bias. In the future, we would like to evaluate more complicated savings questions to determine if this formula learning at the German university level extends to better or worse estimates with and without a calculator. Our intention is to add to the discussion that seeks appropriate ways to assist individuals in making better household financial decisions. We hope that this paper provokes future research to analyze various methods of learning (experiential versus formal) that need to be more thoroughly addressed through more heterogeneous participant pools in order to draw more concrete conclusions.

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<sup>13</sup> Way and Holden (2009) find that only 3% of the surveyed teachers have taken a college course that contained content related to personal finance.



**Appendix 1. Savings question vector.** Details of the eight savings (and debt) questions given to each participant in both rounds of the experiment. Participants only completed the debt questions with a calculator.

Savings Questions (8)		
Prospective (4)	Annual Interest Rate	Time (in years)
Initial balance of \$10,000	7%	12
	12%	36
Retrospective (4)	Annual Interest Rate	Time (in years)
Savings goal of \$100,000	7%	12
	12%	36
Debt Questions (8)		
Mid-Term (4)	Annual Interest Rate	Time Remaining on Loan (%)
Initial 10-year loan of \$20,000	6%	12
	10%	36
Long-Term (4)	Annual Interest Rate	Time Remaining on Loan (%)
Initial 30-year loan of \$200,000	6%	12
	10%	36
<b>Prospective Savings Question</b>		
<p>You currently have a balance of \$10,000 in your account. You leave this money in your savings account for ___ years at a constant annual interest rate of _%.</p> <p>Assume no additional deposits or withdrawals. Interest is compounded annually and reinvested into the account.</p> <p>Based on the above information, estimate your total account balance after ___ years. Please provide your best estimate.</p>		
<b>Retrospective Savings Question</b>		
<p>Your goal is to have \$100,000 in your savings account ___ years from today. Today, you will invest an initial amount of money in your savings account for ___ years at a constant interest rate of _% per year.</p> <p>Assume no additional deposits or withdrawals. Interest is compounded annually and reinvested into the account.</p> <p>How much do you need to invest today in order to reach your savings goal in ___ years? Please provide your best estimate.</p>		
<b>Debt Questions</b>		
<p>Today, you borrow \$_____ for _____ years, paying a yearly fixed interest rate of _____%, agreeing to pay off the entire loan plus interest by making _____ equal monthly payments.</p> <p>Assume all payments have been made on time and no additional payments have been made.</p> <p>After making payments on this loan for _____ years (____ payments), what is the remaining balance of the initial loan? Please provide your best estimate.</p>		

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## Supplement A: Experiment Screenshots

### Introduction Sheet *(Given to each participant at the beginning of the experiment)*

**Thanks for Participating in today's Experiment**

- Please close all other Web Browsers/Programs on your computer.
- You may only use paper and pens provided by the experimenter in section 1 of this experiment.
- Calculators will be provided by the experimenter in the second section and can be used for the remainder of the experiment.


**To Get Started:**


1. Open  in your web browser.
2. Type in your 9 digit
3. Use the unique password (provided by the experimenter).


User	Password
<div></div>	<div></div>


### Welcome Page

Finance Experiment

**Finance Center Münster**  
Lehrstuhl für Finanzierung

  
Experiment auf Deutsch starten


  
Start experiment in English

  
用中文开始实验

[Administration page](#)

## Log in Page

Experiment

 Finance Center Münster  
Lehrstuhl für Finanzierung

Login

Please enter your personal data and click on "Continue" to begin the experiment.

First name

Last name


Password

Your personal data is needed in order to identify you for your payout. The following experiment data is only used anonymously for research purposes.

Continue

## Consent Form

Experiment

 Finance Center Münster  
Lehrstuhl für Finanzierung

Consent form

This consent form asks you to take part in a research study at [REDACTED] YOU MUST BE AT LEAST 18 YEARS OLD TO PARTICIPATE. The reasons for the study, what you will be asked to do, and other important information are discussed below.

This experiment is designed to examine how people do calculations and provide estimates in various household finance decisions. You will be asked to answer questions that will help us discover some of the systematic patterns of human intuition and decision making. You will be asked questions about your personal experience, beliefs, and general feedback about the experiment. None of the material will involve sensitive topics.

Your participation in this study will be confidential and purely voluntary. The show up fee for this experiment is \$10, with an additional variable payout ranging from \$1 to \$10. If you choose, you may stop participating in the study at any time and will then only receive the show up fee.

There are no anticipated risks or benefits associated with this study. If you have any questions, comments or concerns about the research, you can talk to one of the researchers. Please contact Professor [REDACTED]

If you have questions about your rights while taking part in this study, or you have concerns or suggestions and you want to talk to someone other than the researchers about the study, please call the OHRPP at [REDACTED]

I understand that some of my classmates and friends may also be participating in this study. I realize that discussion of the details of this study with them may distort the results. Therefore, I agree not to discuss with any other participant any aspect of the study prior to their participation.

Continue

I have read the above. I understand that my participation is entirely voluntary. I agree to participate with the understanding that I may withdraw at any time. I am at least 18 years old.

By clicking "Continue", you agree to participate in this study and follow instructions. If you fail to follow instructions, you will be asked to leave the study and will not be paid.

Continue




## Introduction


Experiment
<div><b>Finance Center Münster</b> Lehrstuhl für Finanzierung</div> <div><b>Introduction</b><p>Welcome and thank you for participating in this experiment. Your assistance is greatly appreciated.</p><p>This experiment consists of 4 main sections followed by a short questionnaire and will take approximately 60 minutes to complete.</p><p>Please follow the provided instructions and give your best estimate/guess when necessary.</p><p>Please click on "Continue" to start.</p></div> <div>Continue</div>

Experiment
<div><b>Finance Center Münster</b> Lehrstuhl für Finanzierung</div> <div><b>Introduction (continued)</b><p>For the first section, you may use a pencil/pen and paper, which will be provided by the experimenter. No calculators are allowed for section 1.</p><p>After completing section 1, the experimenter will provide you with a calculator. Please only use the calculator provided by the experimenter.</p><p>Using the Internet or other devices (phones, personal calculators, etc.) during this experiment is strictly prohibited and will disqualify you from the experiment without pay.</p><p>Please click "Continue" to continue.</p></div> <div>Continue</div>

## Incentives

Experiment
<div><div><b>Finance Center Münster</b> Lehrstuhl für Finanzierung</div><div><b>Incentives</b><p>Each participant will be given a base amount of \$10 for completing this experiment.</p><p>An additional variable amount will also be paid at the end of the experiment and will be calculated based on your accuracy of one randomly generated question (out of 24) in the first 3 sections of the experiment.</p><p>The additional variable payout ranges from \$1 to \$10.</p><p>The overall payout for participating in today's experiment is \$11 to \$20.</p><p>Please click "Continue" to continue.</p></div></div>
<div>Continue</div>


## Final Instructions

Experiment
<div><div><b>Finance Center Münster</b> Lehrstuhl für Finanzierung</div><div><b>Final instructions</b><p>Please follow the provided instructions and give your best estimate when necessary.</p><p>You may answer each question in whole numbers, for example \$51000, or in 2 decimal points, for example \$51000.34. Please do not use commas in your answers.</p><p>Please note: There is no "Back" button for this experiment. When you click "Continue", you can't go back.</p><p>Please click "Continue" to start section 1.</p></div></div>
<div>Continue</div>

## Savings Question (Retrospective)

Experiment: Section 1

Question 1 of 8

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Your goal is to have \$100,000 in your savings account 36 years from today. Today, you will invest an initial amount of money in your savings account for 36 years at a constant interest rate of 12% per year.

Assume no additional deposits or withdrawals. Interest is compounded annually and reinvested into the account.


**How much do you need to invest today in order to reach your savings goal in 36 years?**

\$

Continue

**This question was provided two times in section 1 after the final prospective and retrospective question.**

Experiment: Section 1


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Please explain, in your own words, how you attempted to answer the previous question. Please be as detailed as possible.

Continue

## Prospective Savings Question

**Experiment: Section 1**  
Question 5 of 8

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You currently have a balance of \$10,000 in your account. You leave this money in your savings account for 36 years at a constant annual interest rate of 7%.

Assume no additional deposits or withdrawals. Interest is compounded annually and reinvested into the account.


**Based on the above information, estimate your total account balance after 36 years. Please provide your best estimate.**

\$

Continue

**Section 1 Complete – Please get a calculator from the instructor.**

**Experiment**

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**You have now completed section 1 of 4.**

**Please notify the instructor to give you a calculator before beginning section 2.**

**Click on "Continue" to start the next section.**

Continue

## Debt Question Format

### Experiment: Section 2

Question 1 of 8



Today, you borrow \$200,000 for 30 years, paying a yearly fixed interest rate of 6%, agreeing to pay off the entire loan plus interest by making 360 monthly payments.

Assume all payments have been made on time and no additional payments have been made.

**After making payments on this loan for 7.5 years (leaving you with 22.5 years/ 270 payments remaining on the loan), what is the balance of the initial loan? Please provide your best estimate.**

\$

Continue

### Experiment: Section 4

Standard (and Much Easier) Financial Questions




Please read the following 15 questions and provide an answer for each question.

Continue

## Financial Literacy (5 Questions) – (van Rooij, Lusardi, & Alessie, 2011)

**Experiment: Section 4**  
Standard (and Much Easier) Financial Questions – Questions 1 to 5 of 15

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1. Suppose you had \$100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?  
☐ More than \$102  
☐ Exactly \$102  
☐ Less than \$102  
☐ I don't know

2. Suppose you had \$100 in a savings account and the interest rate is 20% per year and you never withdraw money or interest payments. After 5 years, how much would you have on this account in total?  
☐ More than \$200  
☐ Exactly \$200  
☐ Less than \$200  
☐ I don't know

3. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?  
☐ More than today  
☐ Exactly the same  
☐ Less than today  
☐ I don't know

4. Assume a friend inherits \$10,000 today and his sibling inherits \$10,000 3 years from now. Who is richer because of the inheritance?  
☐ My friend  
☐ His sibling  
☐ They are equally rich  
☐ I don't know

5. Suppose that in the year 2013, your income has doubled and prices of all goods have doubled too. In 2014, how much will you be able to buy with your income?  
☐ More than today  
☐ The same  
☐ Less than today  
☐ I don't know

Continue

## Numeracy Quiz (10 questions) - (Lipkus, Samsa, & Rimer, 2001)

### Experiment: Section 4

Standard (and Much Easier) Financial Questions – Questions 6 to 10 of 15



6. Imagine that we rolled a fair, six-sided die 1,000 times. Out of 1,000 rolls, how many times do you think the die would come up even (2, 4, or 6)?

Answer:  out of 1000

7. In the BIG BUCKS LOTTERY, the chance of winning a \$10.00 prize is 1%. What is your best guess about how many people would win a \$10.00 prize if 1,000 people each buy a single ticket to BIG BUCKS?

Answer:  persons out of 1000

8. In the ACME PUBLISHING SWEEPSTAKES, the chance of winning a car is 1 in 1,000. What percent of tickets to ACME PUBLISHING SWEEPSTAKES win a car?

Answer:  %

9. Which of the following numbers represents the biggest risk of getting into an auto accident?

- ☐ 1 in 100
- ☐ 1 in 1000
- ☐ 1 in 10

10. Which of the following numbers represents the biggest risk of getting into an auto accident?

- ☐ 1 %
- ☐ 10%
- ☐ 5 %

Continue

### Experiment: Section 4

Standard (and Much Easier) Financial Questions – Questions 11 to 15 of 15



11. If person A's risk of getting a disease is 1% in ten years, and person B's risk is double that of A's, what is B's risk?

Answer:  %

12. If person A's chance of getting a disease is 1 in 100 in ten years, and person B's risk is double that of A's, what is B's risk?

Answer:  out of 100

13. If the chance of getting a promotion at work is 10%, how many people would be expected to get the promotion out of 1000 workers?

Answer:  out of 1000

14. If the chance of getting a divorce is 40 out of 100, this would be the same as having a \_\_\_\_% chance of getting a divorce.

Answer:  %


15. The chance of winning a lottery is .0005. Out of 10,000 people, about how many of them are expected to win this lottery?

Answer:  people

Continue

## Personal Information/Experiment Feedback

**Experiment**  
About you

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Age

Sex  
☐ Male  
☐ Female

Which best describes your status as a student?  
☐ Freshman  
☐ Sophomore  
☐ Junior  
☐ Senior  
☐ Other – please explain:


What is your Major?

Are you an International Student?  
☐ Yes  
☐ No

Which country are you from?

Continue

**Experiment**  
Final questionnaire

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1. The wording of the savings questions was easy to understand.  
☐ Strongly Agree  
☐ Agree  
☐ Neither Agree or Disagree  
☐ Disagree  
☐ Strongly Disagree

2. The wording of the debt/loan questions was easy to understand.  
☐ Strongly Agree  
☐ Agree  
☐ Neither Agree or Disagree  
☐ Disagree  
☐ Strongly Disagree

3. I do not like doing complicated math problems.  
☐ Strongly Agree  
☐ Agree  
☐ Neither Agree or Disagree  
☐ Disagree  
☐ Strongly Disagree

Continue



## Experiment

Final questionnaire

4. I feel comfortable using intuition for making decisions.

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither Agree or Disagree
- ☐ Disagree
- ☐ Strongly Disagree

5. Have you previously taken a math or finance class that taught how to calculate compounding interest?

- ☐ Yes
- ☐ No
- ☐ I don't know

If yes, please name the course/class

If yes, at which school level did you learn this (please check all that apply)

- ☐ Before high school
- ☐ High school
- ☐ College
- ☐ Other – please explain:

Continue

## Experiment

Final questionnaire

6. Do you have experience with any kind of savings products, such as a savings account or other investments?

- ☐ Yes
- ☐ No

If yes, which type of savings/investment products have you used? (please check all that apply)

- ☐ Opened a checking or debit card account
- ☐ Opened a savings account or bought a CD
- ☐ Bought a savings bond or other bonds
- ☐ Invested in mutual funds
- ☐ Invested in individual stocks
- ☐ Other – please explain:

7. Do you have experience with any type of loan/debt products, such as a student/car loan?

- ☐ Yes
- ☐ No

If yes, which type of loans have you made? (please check all that apply)

- ☐ Taken out a loan for student education
- ☐ Taken out an auto loan
- ☐ Taken out a home equity loan
- ☐ Got (or refinanced) a mortgage
- ☐ Got a short-term 'payday' or 'salary advance' loan
- ☐ Got a 'refund anticipation loan' to accelerate the receipt of my taxes
- ☐ Got an auto title loan

- ☐ Used a pawn shop
- ☐ Bought goods on a lay-away plan or at a rent-to-own store
- ☐ Other – please explain:

Continue

## Experiment

Final questionnaire

8. How do you think your performance in this experiment compares to the performance of your fellow students participating in this experiment

- ☐ Much better
- ☐ Better
- ☐ The same
- ☐ Worse
- ☐ Much worse

9. Compared to your fellow students, in which percentile would you consider your performance in this experiment? (Scale from 1 to 100)

Continue

## Experiment

Thank you!

Thank you for participating in this experiment!

You can claim your \$10 now from the experiment supervisor.


Also, the experiment supervisor will inform you about the extra payout amount. Good luck!

Please click on "Finish" to finish the experiment.

Finish

## Administration Page – For Variable Payout Calculations

**Finance Experiment - Administration interface**

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**Login**

Please enter your username and password and click on "Continue" to open the administration interface.

Username

Password

**Finance Experiment - Administration interface**

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Please enter user ID or name of the participant

User ID

First name

Last name

## Finance Experiment - Administration interface

Please enter user ID or name of the participant

User ID  First name  Last name

First name Bryan  
Last name Foltice  
Bruincard ID 123987654

The variable payout amount for this user is **\$1.00** based on the answer to (randomly chosen) question 2.  
Your answer is \$1.00 and the correct answer is \$44,401.20.

[savings\_retrospective: 100000\$,7%,12years]

Return

Okay

Logout

## Finance Experiment - Administration interface

Please enter user ID or name of the participant

User ID  First name  Last name

First name Bryan  
Last name Foltice

The variable payout amount for this user is **\$1.00** based on the answer to (randomly chosen) question 2.  
Your answer is \$1.00 and the correct answer is \$44,401.20.

[savings\_retrospective: 100000\$,7%,12years]

Return

Okay

Logout